



The Naturalistic Study of Driver Distraction

Dr. Richard Hanowski
Director, Center for
Truck and Bus Safety

2nd International Conference on
Driver Distraction and Inattention
Gothenburg, Sweden
September 5-7, 2011

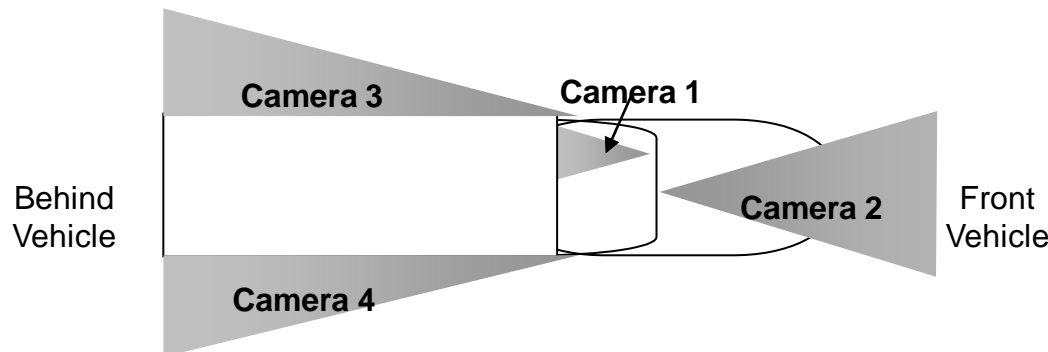


Presentation Overview

- What is naturalistic driving?
- What is “driver distraction”?
- Study examples and key findings
- Exploring (and possible explanations for) some controversial findings
- Research-to-Practice
 - Education
 - Policy
 - HMI Design
- New studies

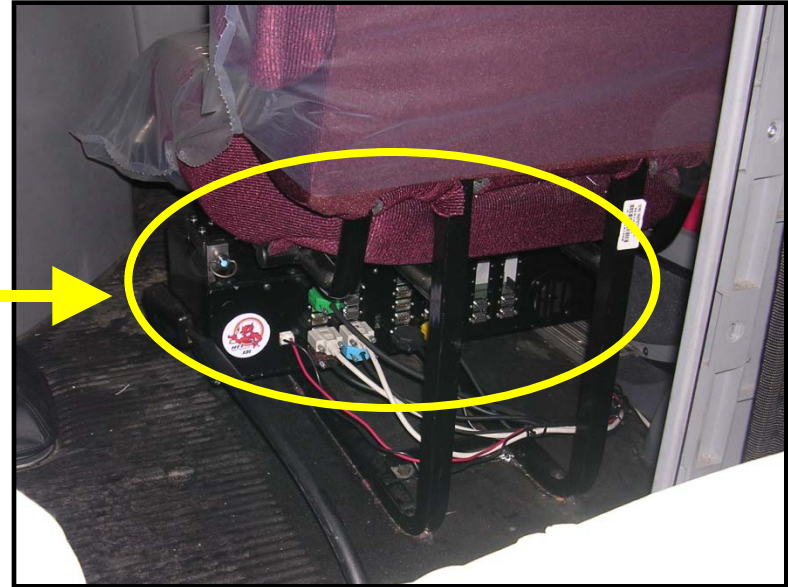
Naturalistic Data Collection

- Study participants use an instrumented vehicle for an extended period (weeks to 1 yr or more)
- Able to get detailed pre-crash/crash information and routine driving behaviors
- Over 100 data measures collected on driving performance (e.g., lane position), actigraphy, questionnaires
- Examples include: 100-Car, Sleeper Berth, L/SH, Teen, Older, Motorcycle...
- High validity and Low control



DAS box under passenger's seat

DAS box



Front VORAD



Rearward Camera



Face & Forward Cameras

What is Driver Distraction?

- US-EU Bilateral ITS Technical Task Force (2010):
 - *Driver distraction is the diversion of attention from activities critical for safe driving to a competing activity.*
- Competing activities and the types of information presented to drivers are wide and varied

Types of Driver Information

- External
 - Information that is outside the vehicle
 - Examples: billboards, traffic lights, street signs etc...

Internal Information

- Information that is inside the vehicle
- Examples: integrated systems, nomadic devices, passengers, etc...

Potential Impact of Information

- Impact of information on driver behavior can be positive (support) or negative (distract)

CVO Distracted Driving Study- Olson et al. (2009)

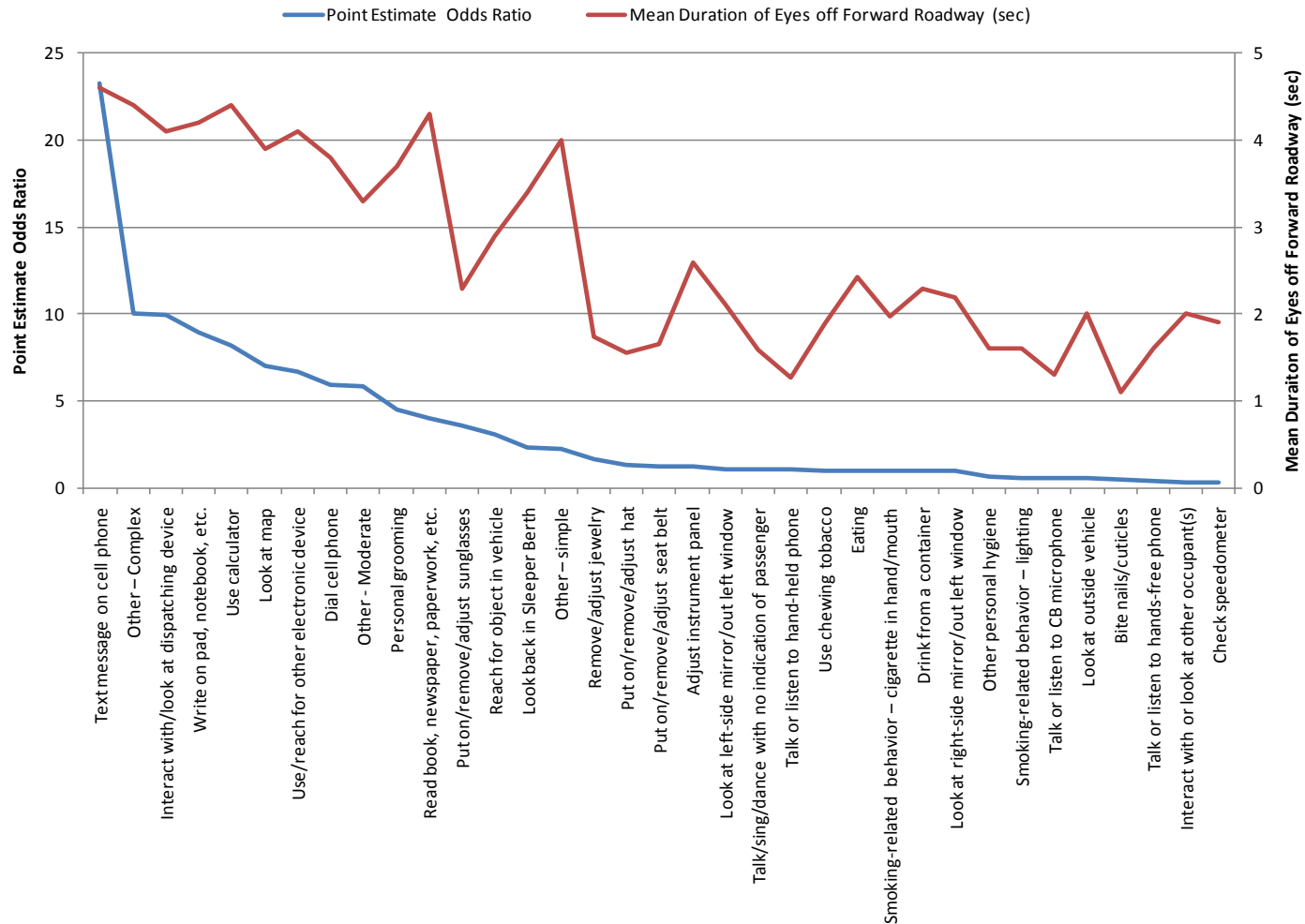
- Use VTTI's naturalistic truck study data
 - 203 drivers, 7 fleets, 55 trucks, 3 million miles
 - Video review of all safety-critical events (n=4452) and baselines/normal driving (n=19,888)
- Identify non-driving tasks/behaviors engaged in immediately prior to involvement in safety events
- What tasks do drivers engage in and do they increase risk?
- What is the impact of tasks on drawing the driver's eyes away from the forward roadway?
- “Instant replay”

Sample of Non-Driving Tasks

- 60% of the safety-critical events had some type of non-driving task being performed

Task	Odds Ratio	LCL	UCL	Frequency of Safety-Critical Events	Frequency of Baselines
Text message on cell phone	23.24	9.69	55.73	31	6
Interact with/look at dispatching device	9.93	7.49	13.16	155	72
Write on pad, notebook, etc.	8.98	4.73	17.08	28	14
Use calculator	8.21	3.03	22.21	11	6
Look at map	7.02	4.62	10.69	56	36
Dial cell phone	5.93	4.57	7.69	132	102
Talk or listen to hand-held phone	1.04	0.89	1.22	195	837
Talk or listen to hands-free phone	0.44	0.35	0.55	91	901
Talk or listen to CB radio	0.55	0.41	0.75	50	399

The *Eyes* Have It



Noted Study Limitations

- *Relatively* few crashes
- *Relatively* few drivers/trucks/miles
- *Volunteer* participants
- Are SCEs valid measures?
- FMCSA-funded study using DriveCam® data was conducted to address these limitations...

VTTI-DriveCam® Distracted Driving Study-Hickman et al. (2010)

- 13,305 vehicles (trucks and buses)
- 1,085 crashes; 39,036 near-crashes and events
- 211,171 baseline (non-events)
- Distraction analysis data- 92 consecutive days from June 6, 2009 through September 5, 2009

DriveCam® Cameras, Views, and Kinematic Data



DriveCam® Videos

- Video examples from DriveCam®

VTTI-DriveCam® Distracted Driving Study Results

Task	Odds Ratio	LCL	UCL	Frequency of Safety-Critical Events	Frequency of Baselines
Cell Phone Usage	1.14*	1.06	1.23	895	4,262

VTTI-DriveCam® Distracted Driving Study Results

Task	Odds Ratio	LCL	UCL	Frequency of Safety-Critical Events	Frequency of Baselines
Cell Phone Usage	1.14*	1.06	1.23	895	4,262
Dialing Cell Phone	3.51*	2.89	4.24	165	256
Talk/Listen Hands Free Cell Phone	0.65*	0.56	0.76	194	1,626
Talk/Listen Hand Held Cell Phone	0.89	0.80	1.00	372	2,266
Reaching for Bluetooth Device	3.38*	2.64	4.31	104	168
Reaching for Cell Phone	3.74*	2.97	4.71	122	178

Are SCE's Valid Safety Measures?

Tertiary Task	Odds Ratios for Tractor Trailers/Tankers Only in Hickman et al. (2010)	Odds Ratios in Olson et al. (2009)
Any Cell Phone Use	1.08	1.04
Dialing Cell Phone	5.44*	5.93*
Talk/Listen Hands-Free Cell Phone	0.58*	0.44*
Talk/Listen Hand-Held Cell Phone	1.01	1.04
Reaching for Bluetooth Device	4.43*	6.72*
Reaching for Cell Phone	7.60*	Included in dial cell phone
Text/Email/Web	+	23.24*
Food/Drink	1.53*	1.01
* Asterisk indicates a significant odds ratio. These ratios are also shown in bold.		
+ odds ratio calculation was only performed across all vehicle types		

Crash

Near-Crash

Near-Crash

Discussion

- What does “Use a Cell Phone” mean?



Task Analysis Primer

- Burnett, Sharma, Pettitt and Stevens (this conference!)
 - GOMS/KLM Modeling used for HMI design and evaluation
- Task Analysis is a commonly used tool in Human Factors Engineering
- Involves task decomposition and the specification of individual steps, or sub-tasks, required to complete a task
- Do this for design/evaluation, why is this not prominent (neglected) in distraction research?
- By not considering risk at the sub-task level, important information is being ignored

“Use a Cell Phone”

- “Use a cell phone” is a higher-order task that is comprised of several sub-tasks
 - Reaching
 - Dialing
 - Talking/listening
 - Texting
 - Etc, etc, etc
- By not assessing the risk of each sub-task, or using terms interchangeably, don’t have a clear picture of the associated risk
- Effect of poorly defined terms is that it can mislead and misinform policy

Research-to-Practice

- Main conclusion of this research is that information presented to a driver can have profound safety implications
- Findings have provided insight to:
 - ***Educators/Trainers***
 - CMV Driving Tips (FMCSA website)
 - National Safety Council's *Motor Fleet Safety Manual*, 5th Edition
 - ***Technology designers***
 - Human factors design of driver-vehicle interfaces
 - ***Policy makers***
 - Trucker texting ban; hand-held cell phone ban (NPRM); model Fleet Distraction Policy (FMCSA website)

TomTom® Study (Antin et al., 2009)

- 38 participants drove instrumented cars on public roads
- Navigation tasks (“wayfinding”)-participants unfamiliar with the routes selected
- Navigation tools
 - Navigation system
 - Paper maps
 - Yahoo printouts
- Navigation system produced the lowest mental effort ratings, fastest reaction time on peripheral detection tasks, fewest driving errors, fewest occurrence of getting lost
- Study results support that notion that an onboard, moving-map navigation system can play a meaningful role in enhancing navigational efficiency and safety.



Ford SYNC® Study (Owens et al., 2010)

- 21 participants drove instrumented cars on public roads and on the **Virginia Smart Road test track**
- **Visual distraction and driving performance** was measured as drivers used handheld phones, mp3 players and the Ford SYNC® system
- Tasks included:
 - Dialing
 - Phone conversations
 - Selecting music tracks
- Drivers able to maintain eyes forward when dialing and selecting tracks with Ford SYNC® but not with handheld devices
- Driving performance (e.g. steering) degraded when dialing and selecting tracks with handheld devices, but not degraded with Ford SYNC®
- No difference when engaged in conversation between handheld phone and the Ford SYNC® - also, no difference from baseline



U.S. DOT Cell Phone Policy Implications

- FMCSA in the process (NPRM) of restricting hand-held phone use, but not talking
 - Hands-free would be permitted
- Unintended consequences: not allowing truck drivers to utilize a drowsiness countermeasure they use may negatively impact safety
- Driving for 11 hours is a monotonous task!

New Naturalistic Studies

- SHRP 2 Safety Program (TRB)
 - ~2,000 cars
 - Canadian cohort in development
- 270 Truck Study (FMCSA)
- Both studies will have analysis opportunities for outside researchers
- Goal of both efforts is for the data to be open access
- Video would have protection (IRB)

Analysis Opportunities

- Kinematic naturalistic data from light vehicle (100-Car) and heavy vehicle (8-Truck) studies available on-line: <http://forums.vtti.vt.edu/>
- Open to all researchers to use the data
- Open forum to add algorithms, etc (e.g., SAFER)
- Workshops (like the one being held tomorrow) provide basic understanding and skills for data mining

Presentation Recap

- *Naturalistic driving*- important approach that **supplements** empirical and epidemiological methods
- *Driver distraction*- a **complex issue** that must be addressed via policy/enforcement, education and well-designed technologies (driver-vehicle interface)
- *Research findings controversy*- lab and *validated* simulator studies can give important information on **expected** driver behavior, but important to investigate **actual** driver behavior that is collected in the **full-context** of the driving environment

Presentation Recap

- *Research to Practice Implications*- naturalistic driving research has provided compelling insight and **scientific support** for safety programs and countermeasures directed at education, policy and design
- Analysis Opportunities- Naturalistic data **are currently available** to answer *your* research questions



Questions?

hanowski@vtti.vt.edu

Sample Naturalistic VTTI Reports and Publications

- **Peer Reviewed Publications**

- Dingus, T.A., Hanowski, R.J. and Klauer, S.G. (in press). Estimating crash risk. *Ergonomics in Design*. HFES, SAGE Publications.
- Hanowski, R.J., Olson, R.L., Hickman, J.S., and Bocanegra, J. (in press). Driver distraction in commercial vehicle operations. In M. Regan, T. Victor and J. Lee (Eds), *Driver distraction and inattention: advances in research and countermeasures*. Ashgate.
- Simons-Morton, B. G., Ouimet, M. C., Klauer, S.G., Lee, S. E. and Dingus, T.A. (in press). The effect of passengers and risk-taking friends on risky driving and crashes/near crashes among novice teenagers. *Journal of Adolescent Health*.
- Klauer, S. G., Simons-Morton, B. G., Lee, S. E., Ouimet, M. C., Howard, E. H., and Dingus, T. A. (2011). Novice drivers' exposure to known risk factors during the first 18 months of licensure: The effect of vehicle ownership. *Traffic Injury Prevention*, 12, 159-168.
- Lee, S.E., Simons-Morton, B.G., Klauer, S.G., Ouimet, M.C., Dingus, T.A. (2011). Naturalistic assessment of novice teenage crash experience. *Accident Analysis and Prevention*, 43 (4), 1472-1479.
- Hickman, J. S., and Hanowski, R. J. (2011). Use of a video monitoring approach to reduce at-risk driving behaviors in commercial vehicle operations. *Transportation Research Part F*, 14, 189-198.
- Wiegand, D.M., Hanowski, R.J., and McDonald, S.E. (2009). Commercial driver's health: A naturalistic study of the body mass index, fatigue, and involvement in safety-critical events. *Traffic Injury Prevention*, 10(6), 573-579.
- Hanowski, R.J., Hickman, J.S., Olson, R.L., Bocanegra, J. (2009). Evaluating the 2003 revised hours-of-service regulations for truck drivers: The impact of time-on-task on critical incident risk. *Accident Analysis & Prevention*, 41, 268-275.
- Hanowski, R. J., Hickman, J. S., Fumero, M. C., Olson, R. L., and Dingus, T. A. (2007). The sleep of commercial vehicle drivers under the 2003 hours-of-service regulations. *Accident Analysis and Prevention*, 39, 1140-1145.

Sample Naturalistic VTTI Reports and Publications

- Hanowski, R. J., Hickman, J. S., Wierwille, W. W. Keisler, A. (2007). A descriptive analysis of light vehicle – heavy vehicle interactions using in situ driving data. *Accident Analysis and Prevention*, 39, 169-179.
- McLaughlin, Shane B., Hankey, Jonathan M., Dingus, & Thomas A. (2007). A method for evaluating collision avoidance systems using naturalistic driving data. *Accident Analysis & Prevention*.
- Hanowski, R. J., Wierwille, W. W., and Dingus, T. A. (2003). An on-road study to investigate fatigue in local/short haul trucking. *Accident Analysis and Prevention*, 35, 153-160.
-
- **Conference Proceedings**
- Dingus, T. A. & Klauer, S. G. (in press). The relative risks of secondary task induced driver distraction. Accepted for publication in *Convergence*: SAE.
- Guo, F., Klauer, C, Hankey, J. and Dingus, T. (Accepted). Using near-crashes as a crash surrogate for naturalistic driving studies. *Transportation Research Record*. Transportation Research Board. The National Academies Press.
- Antin, J. F., Wotring, B. W., and Foley, J. P. (2011). Exploring older driver lateral head rotations at intersections using naturalistic driving data. In *Proceedings of the 6th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design, Driving Assessment 2011*, Olympic Valley, Lake Tahoe, CA, 380-6.
- Hickman, J.S., Bocanegra, J., & Hanowski, R.J. (2011). Distraction in commercial trucks and buses using naturalistic data. *Proceedings of the 89th Annual Conference of the Transportation Research Board*. Washington, DC: Transportation Research Board.
- Doerzaph, Z. R., Dingus, T. A., & Hankey, J. (2010). Improving driver safety through naturalistic data collection and analysis methods. *SAE International Journal of Passenger Cars*, 3(2), 162-169.

Sample Naturalistic VTTI Reports and Publications

- Knippling, R. R., Hanowski, R. J., Hickman, J. S., Olson, R. L., Dingus, T. D., and Carroll, R. J. (2005). Exposure-risk analysis of large truck naturalistic driving data. *Proceedings of the 2005 International Truck & Bus Safety & Security Symposium* (CD-ROM).
- Lee, S. E., Dingus, T. A., Klauer, S. G., Neale, V. L., and Sudweeks, J. D. (2005). Naturalistic data collection of driver performance in familiar and unfamiliar vehicles. Accepted for publication in *Proceedings of the 49th Meeting of the Human Factors and Ergonomics Society*. Santa Monica, CA: Human Factors and Ergonomics Society.
- Neale, V. L., Dingus, T. A., Klauer, S. G., Sudweeks, J., Goodman, M. J. (2005). An overview of the 100-car naturalistic study and findings. *International Technical Conference on the Enhanced Safety of Vehicles* (CD-ROM). Washington, DC: National Highway Traffic Safety Administration.
- Olson, R.L., Hickman, J.S., Knippling, R.R., Hanowski, R.J., and Carroll, R.J. (2005). Factors and driving errors associated with fatigue in a naturalistic study of commercial drivers. Paper and presentation in preparation for the *Fatigue Management in Transportation Operations International Conference*. Seattle, WA: Fatigue Management in Transportation Operations.
- Schreiner, C., Blanco, M., and Hankey, J. M. (2004). Investigation of driving behavior changes associated with manual and voice-activated phone-dialing in a real-world environment. In *Proceedings of the Intelligent Transportation Society of America 14th Annual Meeting and Exposition*. Washington, DC: Intelligent Transportation Society of America.
- Schreiner, C., Blanco, M., and Hankey, J. M. (2004). Investigating the effect of performing voice recognition tasks on the detection of forward and peripheral events. In *Proceedings of the Human Factors and Ergonomics Society 48th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.
- Neale, V. L., Hanowski, R. J., Klauer, S. G., Dingus, T. A. (2003). Lessons learned during two naturalistic truck-driving studies. *Proceedings of the 47th Annual Meeting of the Human Factors and Ergonomics Society* (CD-ROM). Santa Monica, CA: Human Factors and Ergonomics Society.

Sample Naturalistic VTTI Reports and Publications

- Hanowski, R. J., Carroll, R. J., Dingus, T. A., Neale, V. L. (2002). The application of state-of-the-art instrumented vehicles to driving research and its IVI technology assessment. *Proceedings of the 9th World Congress on Intelligent Transportation Systems* (CD-ROM). Washington, DC: Intelligent Transportation Society of America.
- **Book Chapters**
- Klauer, S. G., Perez, M. A., & McClafferty, J. (In press). Instrumented vehicles and in-car recording techniques. In B. E. Porter (Ed.), *Handbook of Traffic Psychology*. Cambridge, MA: Elsevier.
- Hanowski, R.J. and Hickman, J.S. (2010). Managing distracted driving in the commercial motor vehicle. In Brodbeck, J.E. (Ed.), *National Safety Council Motor Fleet Safety Manual, 5th Edition*. Itasca, IL: National Safety Council.
- Hanowski, R.J., Hickman, J.S., Blanco, M., and Fitch, G. (2010). Long-haul truck driving and traffic safety: Studying drowsiness and truck driving safety using a naturalistic driving method. In Verster, J.C. (Ed.), *Sleep, Sleepiness and Traffic Safety*. Hauppauge, NY: Nova Science Publishers.
- Hanowski, R.J. (2009). When Driving, Vision is King. In Knipling, R.R. (Ed.), *Safety for the Long Haul: Large Truck Crash Risk, Causation, & Prevention*. Arlington, VA: American Trucking Association.
-
- **Technical Reports**
- Antin, J.F., Lee, S., Hankey, J., Dingus, T. A. (2011). *Design of the in-vehicle driving behavior and crash risk study in support of the SHRP 2 naturalistic driving study*. SHRP 2 Report S2-S05-RR-1. TRB: Washington, D.C.
- Barr, L. C, Yang, C. Y. D., Hanowski, R. J. and Olson, R. (2011). *An assessment of driver drowsiness, distraction, and performance in a naturalistic setting*. Report No. DOT-VNTSC-FMCSA-04-01. Washington, DC: Federal Motor Carrier Safety Administration.

Sample Naturalistic VTTI Reports and Publications

- Morgan, J.F., Tidwell, S.A., Medina, A., Blanco, M., Hickman, J.S., & Hanowski, R.J. (2011). *Commercial motor vehicle driving simulator validation study (SimVal): Phase II*. Report No. FMCSA-RRR-11-014. Washington, DC: Federal Motor Carrier Safety Administration.
- Soccolich, S., Hickman, J., and Hanowski, R. (June, 2011). *Identifying high-risk commercial truck drivers using a naturalistic approach*. Blacksburg, VA: National Surface Transportation Safety Center for Excellence.
- Hickman, J.S., Hanowski, R.J., and Bocanegra, J. (2010). *Distraction in commercial trucks and buses: Assessing prevalence and risk in conjunction with crashes and near-crashes*. Report No. FMCSA-RRR-10-049. Washington, DC: Federal Motor Carrier Safety Administration.
- Blanco, M., Bocanegra, J.L., Morgan, J.F., Fitch, G.M., Medina, Olson, R.L., Hanowski, R.J., Daily, B., & Zimmermann, R.P. (2009). *Assessment of a drowsy driver warning system for heavy vehicle drivers: Final report*. Report No. DOT HS 811 117. Washington, DC: NHTSA.
- Fitch G. M., Lee S. E., Klauer S., Hankey J., Sudweeks J., and Dingus T. (2009). *Analysis of lane-change crashes and near-crashes*. Report No. DOT HS 811 147. Washington, D.C.: U.S. Department of Transportation.
- Gupta, S., Olson, R., and Hanowski, R. (2009). *Defensive driving tips for CMV drivers: An internet-based approach*. Report No. FMCSA RRT-09-003. Washington, DC: Federal Motor Carrier Safety Administration.
- McLaughlin S. B., Hankey J. M., Klauer S. G., and Dingus T. A. (2009). *Contributing factors to run-off road crashes and near-crashes*. Report No. DOT, HS 811 079. Washington, D.C.: National Highway Traffic Safety Administration.
- Olson, R.L., Hanowski, R.J., Hickman, J.S., & Bocanegra, J. (2009). *Driver distraction in commercial vehicle operations, final report*. Report No. FMCSA-RRR-09-042. Washington, DC: Federal Motor Carrier Safety Administration.

Sample Naturalistic VTTI Reports and Publications

- Wiegand, D. M., Hanowski, R. J., & McDonald, S. E. (2009). *Commercial driver health and fatigue study*. Blacksburg, VA: National Surface Transportation Safety Center for Excellence.
- Wiegand, D. M., McClafferty, J., McDonald, S. E., & Hanowski, R. J. (2009). *Development and evaluation of a naturalistic observer rating of drowsiness protocol*. Blacksburg, VA: National Surface Transportation Safety Center for Excellence.
- Hanowski, R.J., Blanco, M., Nakata, A., Hickman, J.S., Schaudt, W.A., Fumero, M.C., Olson, R.L., Jermeland, J., Greening, M., Holbrook, G.T., Knipling, R.R., and Madison, P. (2008). *The drowsy driver warning system field operational test, data collection methods final report*. Report No. DOT HS 810035. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration
- Hanowski, R.J., Olson, R.L., Bocanegra, J., and Hickman, J.S. (2008). *Analysis of risk as a function of driving-hour: Assessment of driving hours 1 through 11*. Report No. DTMC75-07-D-00006, Task Order 3. Washington, DC: Federal Motor Carrier Safety Administration.
- Wiegand, D. M., Hanowski, R. J., Olson, R., & Melvin, W. (2008). *Fatigue analyses from 16 months of naturalistic commercial motor vehicle driving data*. Blacksburg, VA: National Surface Transportation Safety Center for Excellence.
- Klauer, S. G., Dingus, T.A., Neale, V.L., Sudweeks, J.D., and Ramsey, D.J. (2006). *The impact of driver inattention on near crash/crash risk: An analysis using the 100-Car Naturalistic Driving study data* (DOT HS 810 594). Washington, DC: National Highway Traffic Safety Administration.
- Klauer, S. G., Dingus, T. A., Neale, V. L., Sudweeks, J.D., and Ramsey, D. J. (2006). *The study of methodological and crash avoidance issues using the 100-Car Naturalistic study data, subtask 2-driving distraction analysis* (Report No. DOT HS 810 594). Washington, DC: National Highway Traffic Safety Administration.

Sample Naturalistic VTTI Reports and Publications

- Dingus, T. A., Klauer, S. G., Neale, V. L., Petersen, A., Lee, S. E., Sudweeks, J., Perez, M. A., Hankey, J., Ramsey, D., Gupta, S., Bucher, C., Doerzaph, Z. R., Jermeland, J., and Knipling, R.R. (2005). *The 100-Car Naturalistic Driving study: Phase II – results of the 100-car field experiment* (DOT HS 810 593). Washington, DC: National Highway Traffic Safety Administration.
- Neale, V. L., Klauer, S. G., Knipling, R. R., Dingus, T. A., Holbrook, G. T., Petersen, A. D. (2002). *The 100-Car Naturalistic Driving study: Phase I – experimental design* (DOT HS 809 536). Washington, DC: U.S. Department of Transportation, National Highway Traffic and Safety Administration.
- **Other**
- CMV Web-Based Driving Tips: <http://www.fmcsa.dot.gov/about/outreach/education/drivertips/index.htm>
- Available databases: <http://forums.vtti.vt.edu/>